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1. These are the same temperatures. The average kinetic energy is the same in both samples.
2. The pressure is caused by the sum total of all collisions of the particles of the gas and the walls of the container.
3. Increasing the temperature causes the particles to move faster and therefore hit the walls harder, thus raising the pressure.
4. This term describes the idea that the size of the particles is small compared to the spaces between them and explains why gases are so highly compressible.
5. The volume and the amount of gas must be controlled.
6. The balanced chemical reaction will tell you the ratios of the volumes of the gases involved.
7. The higher the temperature, the higher the vapour pressure. This means that there is more water vapour in a sample of gas at a higher temperature.

Answers to Applying Concepts Questions

8. The volume should drop to one-third of its original value.
9. Yes, as long as the temperatures are measured in absolute degrees. This is the statement of Charles's law.
10. $A(g) + 4B(g) \rightarrow 2C(g)$
11. Yes, if the gases are at STP. This follows from Avogadro's law.
12. The density goes up with an increase in pressure and down with an increase in temperature.

Answers to Solving Problems Questions

13.	**(a)** 173 K	**(b)** –273 °C	**(c)** 516.7 K
14.	**(a)** 2.50 bar	**(b)** 374 kPa	**(c)** 1.29 atm

15. 0.427 L

16. 115 kPa

17. 5 L

18. 6.20 L

19. 1.9 L

20. 3.3 L

21. 22.6 L/mol

22. 0.19 mol

23. 3.8 L

24. 54 kPa in both

25. **(a)** 20.0 g/mol

(b) polar molecule, acidic in water: hydrogen fluoride

(c) 0.809 g/L

26. 1.78 g/L

27. In order to determine the universal gas constant, the students must be able to collect data on volume, pressure, temperature, and the moles of the gas. Both methods would allow for the collection of all of this data; however, the procedure that would have to be followed in both cases would be significantly different. Given the laboratory equipment available in a high school laboratory, it would be significantly easier to collect gas in a plastic bag. Also, a plastic bag would be quite light initially, so the small change in mass would be measurable and a significant change. Collecting a gas under pressure could prove difficult in a high school laboratory and the container in which it would be collected may not change in mass significantly. Collecting gas in a plastic bag would be the method of choice in a high school laboratory.

Answers to Making Connections Questions

28. All three gases, helium, hydrogen, and hot air will cause a balloon to rise. Helium, hydrogen, and air, when heated, are less dense than regular air and will therefore rise. Currently, helium is used in "dirigibles," like the Goodyear Blimp, while hot air is used in most balloons in Alberta. Hydrogen gas is no longer commonly used in passenger ballooning as, although it is relatively inexpensive, it is very flammable. It is still used in weather balloons. Both helium and hot air are viable choices, with hot air being significantly less expensive and more readily available.

29. (a) $2C_8H_{18}(l) + 25O_2(g) \times 16CO_2(g) + 18H_2O(g) +$ energy

(b) The mixture is at a higher temperature when the piston is at the top at the end of the compression stroke.

(c) $N_2(g) + O_2(g) \rightarrow 2NO(g)$; the nitrogen is present in the air and reacts with the oxygen at the high temperatures inside the cylinder.

30. When an airbag deploys, a chemical reaction occurs that releases nitrogen gas. The ideal gas law, $PV = nRT$ is important in ensuring that enough, but not too much, gas is released into the bag for the volume of the bag and the temperature of the surroundings. If too much gas is released, the pressure inside the airbag may be too high, which could cause injury or perhaps the bag could explode. If not enough gas is released, then the bag may not provide enough cushioning for the crash. Since the conditions are not changing, the combined gas law is not applicable. Although airbags are designed to operate in wide-ranging temperature conditions, it is possible that extremely high or low temperatures may cause an airbag to inflate too much (high temperatures) or not enough (low temperatures), which may lead to unexpected injuries.